Revision History

Rev. 1.1

Revision	**Date**	**Description**
1.0	2006/10/17	First Release
1.1	2007/9/10	1. M-501 V3 hardware modification Change the CN3 Pin 38 (PIO13) mapping from CPU’s PC6 to PB22. Firmware is also changed accordingly to ensure 100% software compatibility with M-501 V2. **Reason:** ATMEL technical note suggests not to use PC6 as Digital I/O pin. 2. SDRAM memory upgrade to 64MB in M-501 V3 3. Supervisor (root) can only uses *SSH* to login. If user want to allow supervisor (root) to use ***telnet*** login, he simply remove the file ***/etc/securetty*** *4.* PIO24 to PIO31 are reserved for serial ports, RS-232/422/485 interface selection.
1.2	2008/5/22	1. Kernel dated 2008/5/52 released 2. Support 2G SD card (SD 1.0) 3. Support software control RTS/CTS signals 4. Support interrupt function for GPIO 5. Support speed configuration for spi 6. Add logger utility 7. Enable the SD card write protect (CN3 pin 24) and card detect (CN3 pin 23) functions

Overview

M501 is an ARM9-based Linux ready System on Module. The M501 is equipped with an ATMEL AT91RM9200 SoC and features:

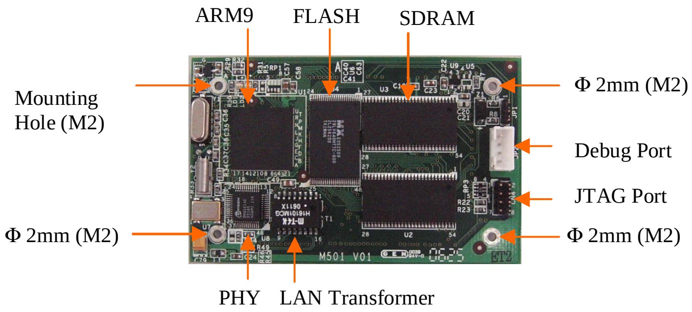
1. ARM920T ARM Thumb Processor with 200MIPS at 180MHz, Memory Management Unit
2. 16-KByte Data Cache and 16-KByte Instruction Cache
3. 64MB SDRAM, 16MB Flash
4. One 10/100 Mbps Ethernet with MAC/PHY and transformer
5. Two USB 2.0 full speed (12 Mbps) Host Ports
6. Multimedia Card Interface for SD memory card
7. Four UARTs with hardware and software flow control
8. Two-wire Interface (I2C) for Real Time Clock
9. 32 Programmable Digital I/O Port
10. 8-bit external local bus interface

Linux 2.6 OS is pre-installed in the flash disk of M501 and many powerful utility programs are also included. GNU C/C++ tool chain are shipped with M501 in CD. Therefore, M501 is ready to drop in your design to save your time in software porting and hardware debug.

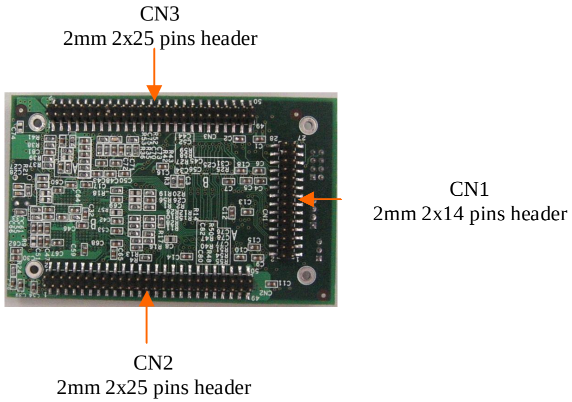
Artila uses M-501 to design Matrix-510/520. Please refer to Matrix-510/520 user guide and if you are interested in those design, please contact Artila.

M-501 Layout

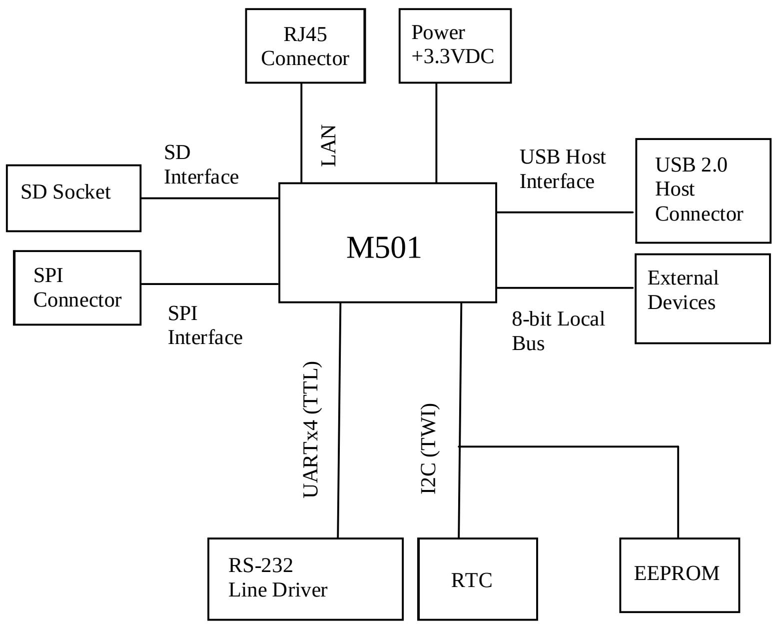
Front View



Rear View



Function Block Diagram



M501 Hardware Specifications

SoC: ATMEL AT91RM9200
CPU: ARM920T ARM Thumb Processor with Memory Management Unit (MMU)
Clock: 180MHz
SDRAM: 64MB
Flash: 16MB Intel StrataFlash or Equivalent
Ethernet: 10/100 Mbps with MAC/PHY and Transformer
PHY: DAVCOM DM9161
Transformer: 1.5 KV isolation
Signal: ***ETX0+, ETX0-, ERX0+, ERX-***
USB : USB 2.0 full speed (12Mbps) Host x2
Signal: ***UDataA+, UDataA-, UDataB+, UDataB-***
UART: Four Universal Asynchronous Receiver and Transmitter
Data Bits: 5 to 9 bits
Parity: None, Even, Odd, Mark, Space
Stop: 1, 1.5, 2 bits
Baud Rate: Up to 921.6 Kbps
Flow Control: RTS/CTS, XON/XOFF, None
Multi-drop Mode with address generation and detection (COM1 only)
RS485 Driver Control Signal (COM1:RTS0)
Signal Level: CMOS/3.3V compatible
COM1: ***TXD0, RXD0***, ***RTS0***, ***CTS0*** (RS485 Control: ***RTS0***)
(Software configurable RS-232/422/485)
COM2: ***TXD1***, ***RXD1***, ***RTS1***, ***CTS1***, ***DCD1***, ***DTR1***, ***DSR1***
(RS-232 with full modem control)
COM3: ***TXD2***, ***RXD2***, ***RTS2***, ***CTS2***
(RS-232 with hardware flow control)
COM4: ***TXD3***, ***RXD3***, ***RTS3***, ***CTS3***
(RS-232 with hardware flow control)
Inter-IC Bus: (I2C Bus)
Compatible with standard two-wire serial memory interface
Supported Devices: (Driver built-in)
Real Time Clock: Ricoh (RS5C372)
EEPROM: ATMEL AT24C16 and compatible
Signal: ***TWD, TWDK***
I2S (internal IC Sound):
Transmitter: ***TSCK, TWS, TSD***
Receiver: ***RSCK, RWS, RSD***
Serial Peripheral Interface: (SPI)
Two chip Selects with external decoder
Three wires signals: MISO, MOSI and SPCK clock
Signal: ***MISO, MOSI, SPCK, CS1, CS2***
Multimedia Card Interface
Compatible with SD memory card Specification 1.0
Signal: ***MCCDA, MCCK, MCDA0, MCDA1, MCDA2, MCDA3***
Watchdog Timer: CPU built-in WDT and used by Linux Kernel

Programmable DIO
32 General Purpose IOs and can be programmable as digital input or output
Support interrupt function for digital inputs
Signal Level: CMOS/3.3V Compatible
Input: (programmable with 15K Ohm pull-up resistor)
Low level: -0.3V min
+0.8V max
High level: +2V min
+3.9V max
Output:
Low level: +0.4V max @0mA
+0.2V min @ 8mA
High level: +3.1V max @0mA
+2.9V min @ 8mA
Signal: ***PIO0 to PIO31*** (Default setting: Input without pull-up resistor)
Note: PIO24 to PIO31 are reserved for RS-232/422/485 interface selection for serial ports 1 to 4. Please contact Artila if you want to use PIO24 to PIO31.

External Bus Interface:
8-bit data bus
Signal: ***D0~D7***
8-bit address bus
Signal: ***A0~A7***
4 Chip Selection
Signal: ***NCS3~NCS6***
Signal Level: CMOS/3.3V

Predefine Pins:
Reset Button (CN2, pin#35, ***RST#1***), input
Buzzer (CN2, pin#37, ***BUZR***), output
System ready LED (CN2, pin#38, ***RDY_LED***), output
LAN activity LED (CN3, pin#11, ***ACT_LED***), output

Undefined Digital IO Pins (reserved)
CN1: pin#23, #24, #25, #26
CN3: pin#23, #24

Debug Port:
Serial Console: Tx/Rx
Signal: ***Tx*** share with ***RTS2***
Rx share with ***CTS2***
JTAG: For low level debug
Signal: ***NTRST, TDI, TMS, TCK, TDO***
Power:
Input: 3.0 to 3.6VDC (3.3V nominal)
Consumption: 2.5W

M501 Software Specifications

OS: Linux 2.6.14
Boot Loader: U-Boot 1.1.2
File System: JFFS2, EXT2/EXT3, VFAT/FAT, NFS
Protocol Stacks:
IPV4, ICMP, ARP, DHCP, NTP, TCP, UDP, FTP, Telnet, HTTP, PPP, PPPoE, CHAP, PAP, SMTP, SNMP V1/V3, SSL, SSH 1/2
Utilities:

- Bash: Shell Command
- Tinylogin: Login and user manager utility
- Telnet: Telnet client program
- Busybox: Linux utility collection
- FTP: FTP client program

Daemon

- pppd: Dial In/out over serial port and PPPoE
- snmpd: SNMP agent program
- telnetd: Telnet server program
- inetd: TCP server program
- ftpd: FTP server program
- boa: Web server program
- sshd: secured shell server
- iptables: Firewall service manager
- armd: Artila manager daemon

Tool Chain for Windows/Linux
GCC: C/C++ PC cross compiler
GLIBC: POSIX Library
Standard Device Drivers:
ttyS0: serial console port (AT91RM9200 debug port)
ttyS1~ttyS4: serial ports (AT91RM9200 UART0~UART3)
gpio: General Purpose I/O
mmc: SD/MMC:
rtc: Real Time Clock
sda: USB flash memory disk
ttyACM: USB Modem
ttyUSB: USB RS-232 adaptor
spi: spi bus

<u>Default Setting</u>
Default IP Address:192.168.2.127
Netmask: 255.255.255.0
ssh Login: root
Password: root
Telnet Login: guest
Password: guest
Terminal type: VT100

<u>Network Configuration</u>
To configure the IP address, Netmask and Gateway setting, please modify **/disk/etc/rc** as following:
#Static IP
ifconfig eth0 192.168.2.127 netmask 255.255.255.0
For DHCP setting:
#DHCP
dhcpcd eth0 &

<u>Wireless LAN Configuration</u>
M-501 supports wireless LAN by using USB WLAN adaptor which uses Ralink RT2571 controller. Please refer to the website <u>http://ralink.rapla.net</u> for the supporting list of the USB WLAN adaptor. To configure the wireless LAN setting, please use command:
ifconfig wlan0 up
iwconfig wlan0 essid XXXX key YYYYYYYY mode MMMM
For infrastructure mode XXXX is the access point name and YYYYYYYY is the encryption key and MMMM should be ***managed***
For Ad-Hoc mode mode XXXX is the M-501 device name and YYYYYYYY is the encryption key MMMM should be ***ad-hoc***. To configure the IP address use command
dhcpcd wlan0 & or ***ifconfig wlan0 192.168.2.127 netmask 255.255.255.0***

<u>Install GNU Tool Chain</u>
Find a PC with Linux 2.6.X Kernel installed and login as a **root** user then copy the arm-linux-3.3.2.tar.gz to root directory \ of PC. Under \ directory type following command to install the M-501 Tool Chain
#tar zxvf arm-linux-3.3.2.tar.gz

<u>I/O Devices Control</u>
M-501 uses standard I/O device control to access following devices:

1. Ethernet: eth0
2. Serial Ports: ttyS1, ttyS2, ttyS3,ttyS4
3. Serial Console Port: ttyS0
4. Real time clock: rtc
5. USB Flash Disk: sda, sda1, sdb, sdb1
6. SD memory Card: mmc0
7. USB WLAN dongle: wlan0
8. USB Serial Cable: ttyUSB0, ttyUSB1
9. SPI bus: spi0, spi1

Remark: Remember to include the “matrix500.h” header file in your program. Please refer to the example program included in the M-501 SDK CD to demo the RS-232/422/485 mode configuration of serial port 1 configuration.

<u>File System</u>
Matrix 500 uses jffs2 file system for the built-in flash memory disk. The directory are:
/disk
/home
/etc
Write data to these directories are saved to flash memory and will not be erased after power off.

<u>Mount External Disk</u>
To mount the USB Flash Disk and SD memory card, use following commands after the disk are installed properly. To mount USB disk
mount /mnt/sda or ***mount /mnt/sda1*** or ***mount /mnt/sdb*** or ***mount /mnt/sdb1***
To find out the device name of the USB disk, you can use
dmesg | grep sd
And to mount SD memory card
mount /mnt/mmc

<u>Web Page Directory</u>
The web pages are placed at /home/httpd and the boa.conf contains the boa web server settings. The home page name should be ***index.html***

<u>Welcome Message</u>
The welcome message “Artila” can be modified by editing the ***/etc/motd*** file.

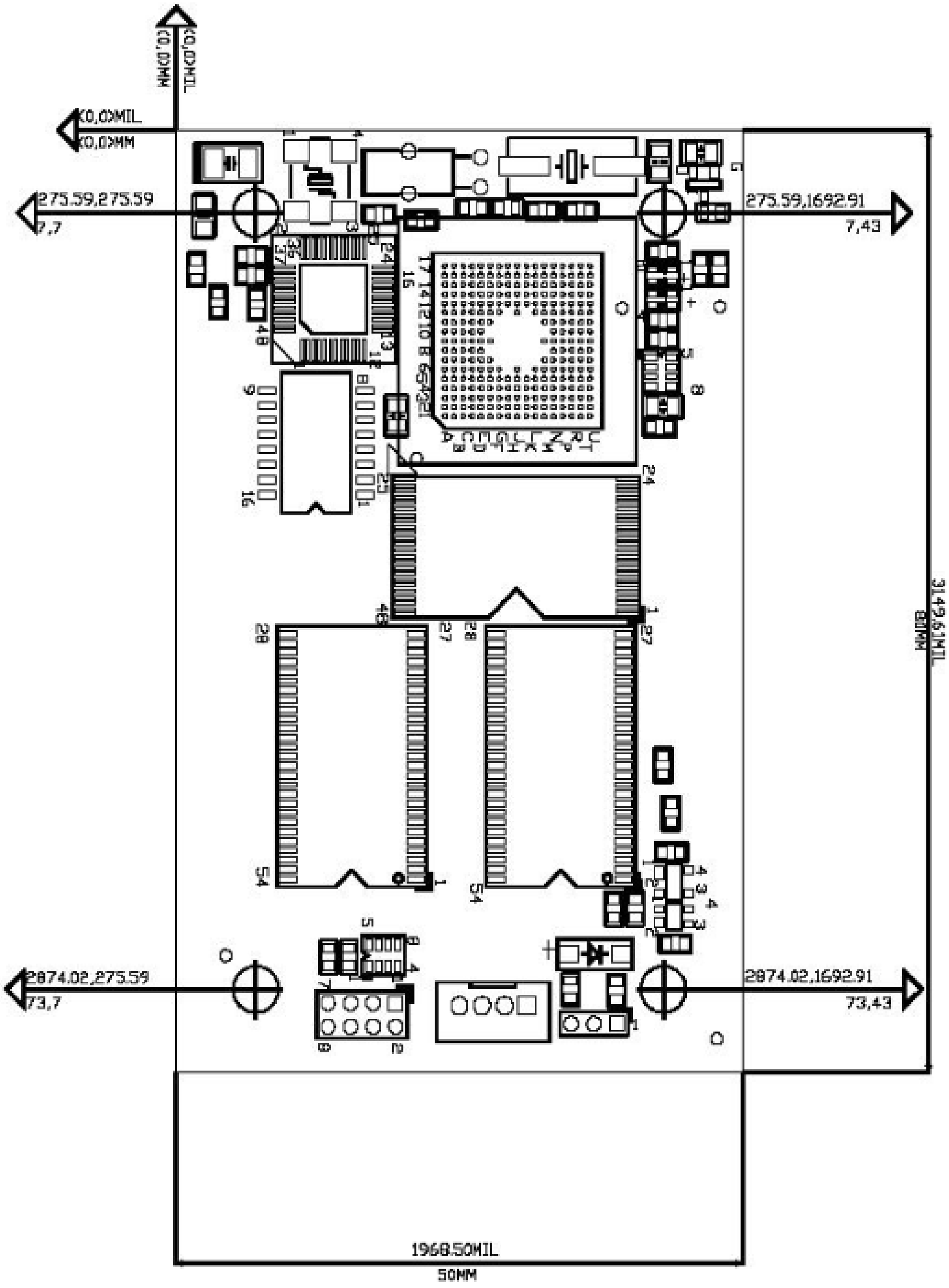
<u>Manager Utility Software</u>
The Manager Utility software, **manager.jar** is a java program and is used to discovered the Matrix 500 in the network if the IP address is forgotten. It can be run at any OS where java run time is available. To install the java run time platform at your computer, please visit **<u>http://java.sun.com</u>** and download the Java 2 Standard Edition (J2SE). Once the Matrix 500 is found, you can click the Telnet Console to configure the Matrix 500

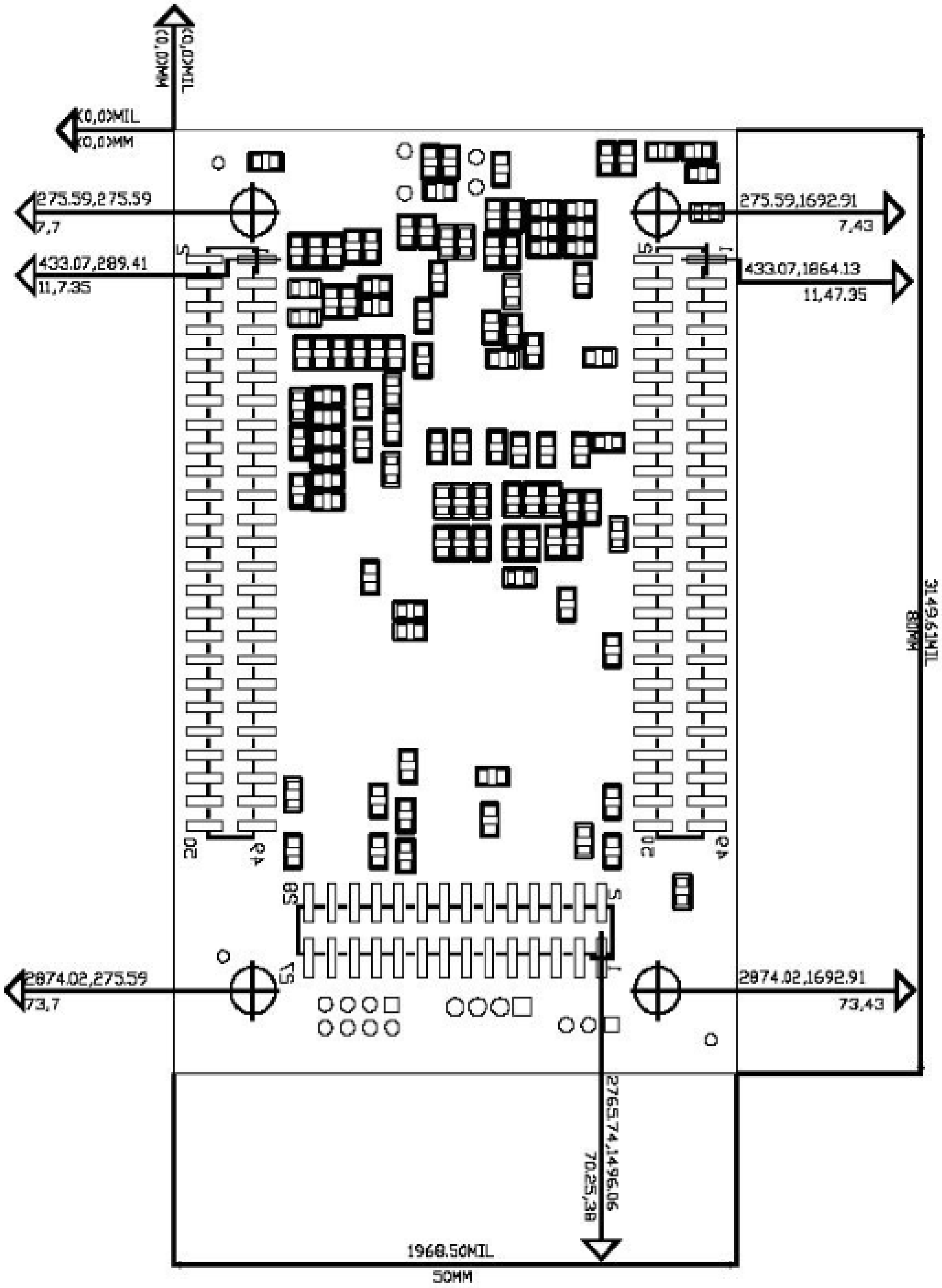
<u>Upload file to M-501</u>
To upload the file to M-501, you can use FTP command in command line or Web Browser such as Microsoft Internet Explorer. Type **<u>ftp://192.168.2.127</u>** and under the file menu, click log on option to login M-501. After login, you can see the files system of M-501.

<u>Compile and upload the C program</u>
Use following command of the GNU cross compiler to compile the C program
#arm-linux-gcc –o hello hello.c

Then upload the ***hello*** to M-501. Remember to change the mode of the file
After upload to M-501 by
chmod +x hello

M501 Mechanical Dimension





Pin Assignment and Definition

Function	CPU	SoM	CN1	CN1	SoM	CPU	Function
(Addr Bus)	**A0**		1	2		**D0**	(Data Bus)
(Addr Bus)	**A1**		3	4		**D1**	(Data Bus)
(Addr Bus)	**A2**		5	6		**D2**	(Data Bus)
(Addr Bus)	**A3**		7	8		**D3**	(Data Bus)
(Addr Bus)	**A4**		9	10		**D4**	(Data Bus)
(Addr Bus)	**A5**		11	12		**D5**	(Data Bus)
(Addr Bus)	**A6**		13	14		**D6**	(Data Bus)
(Addr Bus)	**A7**		15	16		**D7**	(Data Bus)
(Write Enable)	**NWE NWR0**		17	18		**NOE NRD**	(Read Enable)
(Chip Select)	**NCS3**	**CS3**	19	20	**CS4**	**NCS4**	(Chip Select)
(Chip Select)	**NCS5**	**CS5**	21	22	**CS6**	**NCS6**	(Chip Select)
(N/A)	PA21		23	24		PA24	(N/A)
(N/A)	PB7		25	26		PB18	(N/A)
	VCC3		27	28		GND	
			CN1				

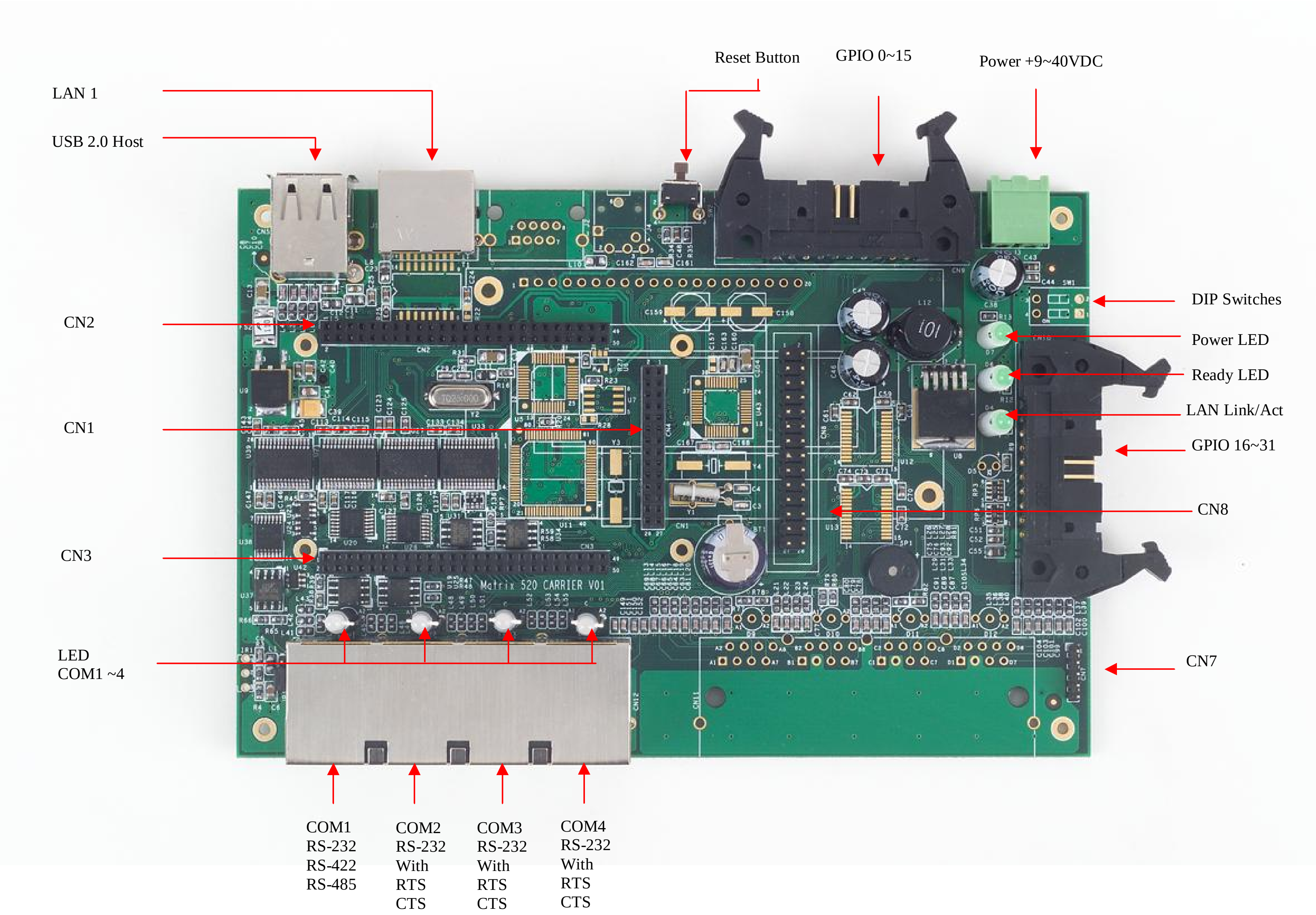
Pin Assignment and Definition

Function	CPU	SoM	CN2	CN2	SoM	CPU	Function
(COM2)	CTS2		1	2		DSR2	(COM2)
(COM2)	RTS2		3	4		RXD3	(COM3)
(COM3)	TXD3		5	6		CTS3	(COM3)
(COM3)	RTS3		7	8		TXD4	(COM4)
(COM4)	RXD4		9	10		RTS4	(COM4)
(COM4)	CTS4		11	12		PD22	(GPIO)
(GPIO)	PD23		13	14	PIO16	PC14	(GPIO)
(GPIO)	PC15	PIO17	15	16	PIO18	PD7	(GPIO)
(GPIO)	PD8	PIO19	17	18	PIO20	PD9	(GPIO)
(GPIO)	PD10	PIO21	19	20	PIO22	PD11	(GPIO)
(GPIO)	PD12	PIO23	21	22	PIO24	PD13	(GPIO)
(GPIO)	PD14	PIO25	23	24	PIO26	PD15	(GPIO)
(GPIO)	PD16	PIO27	25	26	PIO28	PD17	(GPIO)
(USB B+)	HDPB	UdataB+	27	28	UdataB-	HDMB	(USB B-)
(USB A-)	HDMA	UdataA-	29	30	UdataA+	HDPA	(USB A+)
(GPIO)	PD18	PIO29	31	32	PIO30	PD26	(GPIO)
(GPIO)	PD27	PIO31	33	34		VCC3 PWROK	(System Reset)
(Reset Btn)	BTNRST#		35	36		NTRST	(JTAG Reset)
(Buzzer)	PB6		37	38		PD6	(System Ready LED)
(I2S transmitter)	TF2	TWS	39	40	TSCK	TK2	(I2S transmitter)
(I2S transmitter)	TD2	TSD	41	42	RSD	RD2	(I2S receiver)
(I2S receiver)	RK2	RSCK	43	44	RWS	RF2	(I2S receiver)
	GND		45	46		GND	
	GND		47	48		GND	
	VCC3		49	50		VCC3	
			CN2				

Pin Assignment and Definition

Function	CPU	SoM	CN3	CN3	SoM	CPU	Function
	VCC3		1	2		VCC3	
	GND		3	4		GND	
	GND		5	6		GND	
(LAN)	**ERX0-**		7	8		**ERX0+**	(LAN)
(LAN)	**ETX0-**		9	10		**ETX0+**	(LAN)
(LAN LED)		ACTLED#	11	12		**MISO**	(SPI)
(SPI)	**MOSI**		13	14		**SPCK**	(SPI)
(SPI)	**NPCS0**		15	16		**NPCS1**	(SPI)
(SD)	**MCCK**		17	18		**MCCDA**	(SD)
(SD)	**MCDA0**		19	20		**MCDA1**	(SD)
(SD)	**MCDA2**		21	22		**MCDA3**	(SD)
(Card Detect)	PD19		23	24		PD20	(SD Write Protect)
(I2C)	**TWD**		25	26		**TWCK**	(I2C)
(GPIO)	PA19	**PIO1**	27	28	**PIO3**	PB2	(GPIO)
(GPIO)	PB8	**PIO4**	29	30	**PIO5**	PB9	(GPIO)
(GPIO)	PB10	**PIO6**	31	32	**PIO7**	PB11	(GPIO)
(GPIO)	PC0	**PIO8**	33	34	**PIO9**	PC1	(GPIO)
(GPIO)	PC2	**PIO10**	35	36	**PIO11**	PC3	(GPIO)
(GPIO)	PC5	**PIO12**	37	38	**PIO13**	PB22	(GPIO)
(GPIO)	PB28	**PIO14**	39	40	**PIO15**	PB29	(GPIO)
(GPIO)	PD24	**PIO0**	41	42	**PIO2**	PD25	(GPIO)
(COM1)	**TXD1**		43	44		**RXD1**	(COM1)
(COM1)	**CTS1**		45	46		**RTS1**	(COM1)
(COM2)	**DTR2**		47	48		**TXD2**	(COM2)
(COM2)	**RXD2**		49	50		**DCD2**	(COM2)
			CN3				

M501 Evaluation Board Layout



Step 1: M-501 serial console port (ttyS0) shares three data pins with serial port P3 (RS-232 port ttyS3).

ttyS0. Tx <=> ttyS3. RTS
ttyS0. Rx <=> ttyS3. CTS
ttyS0.GND <=> ttyS3. GND

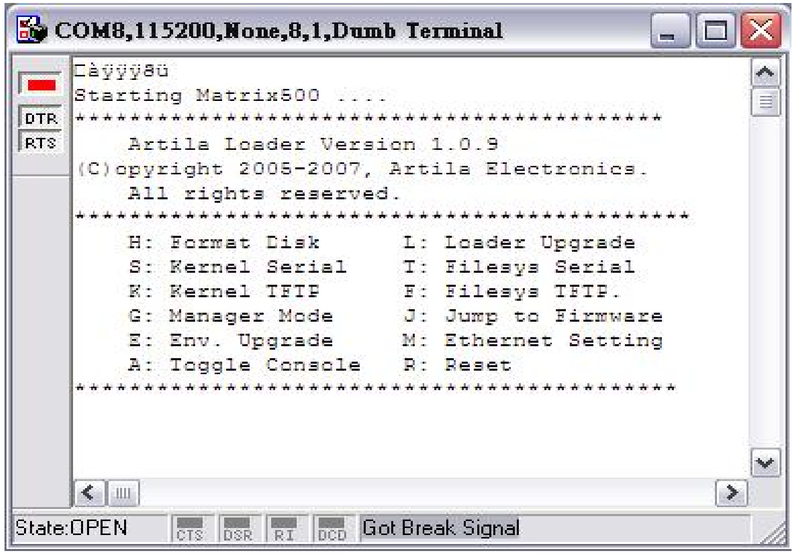
Connect the Console cable to Port 3 and the serial port of your computer

Console Port via P3 Connector

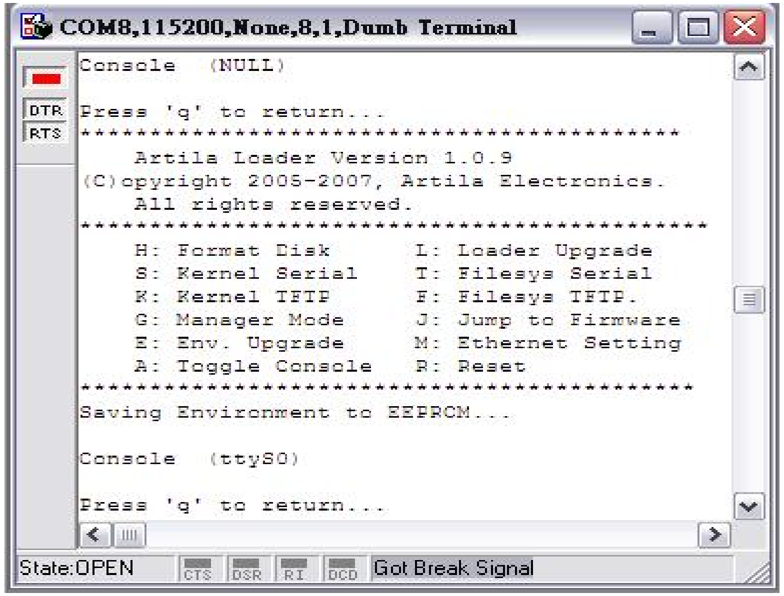
Pin	RS-232
1	
2	TXD
3	GND
4	
5	
6	
7	RXD
8	

Step 2: Once the serial console (ttyS0) are connected correctly to your PC, you need to use a terminal software such as hyper terminal of Microsoft and the serial port setting as 115200,N,8,1 and no flow control. Terminal type is VT100.

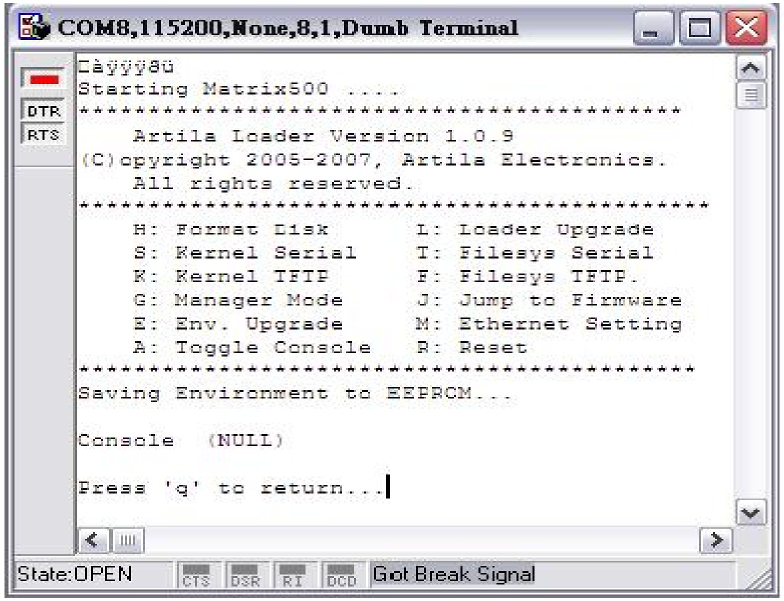
Step 3: Power on M-501 then you will see the message from your terminal software as follow:
Once "Starting Matrix 500" appears, please keep typing "@" to trigger the serial load program. Then you will see the Artila loader menu appear. If you miss the trigger procedure, please reset the M501 and repeat step 3 again.



Step 4: Now you can type "A" to enable the serial console function. Once you see the console is enabled as follow, Press "q" to return to main menu of console. Then please type "R" to reboot the system.



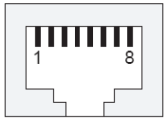
Step 5: Once you complete system debug, please remember to disable the serial console using the Toggle Console item by typing "A"..



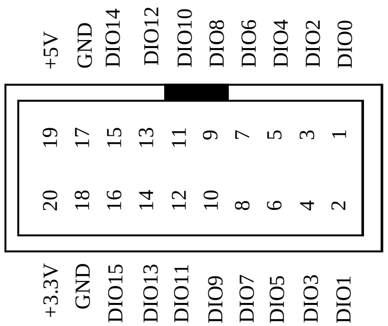
Pin Assignment of Connectors

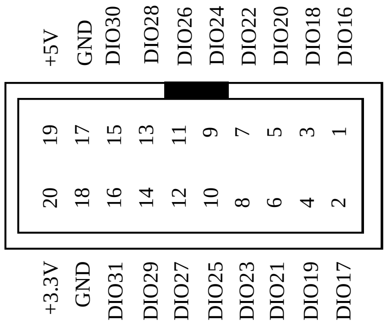
LAN 1 and LAN2

Pin	Signal
1	ETx+
2	ETx-
3	ERx+
6	ERx-



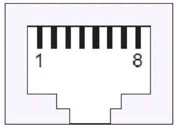
GPIO Port 0~15 and GPIO Port 16



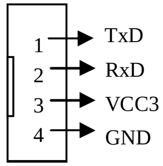


COM Port

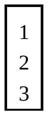
Pin	RS-232	RS-422	RS-485
1		---	---
2	RTS	TXD+	Data+
3	GND	GND	GND
4	TXD	TXD-	Data-
5	RXD	RXD+	---
6		RXD-	---
7	CTS	---	---
8		---	---



JP2 Serial Console Port

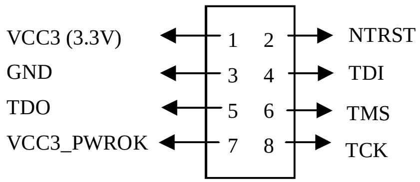


JP1 of M501
Boot Mode Selection Jumper



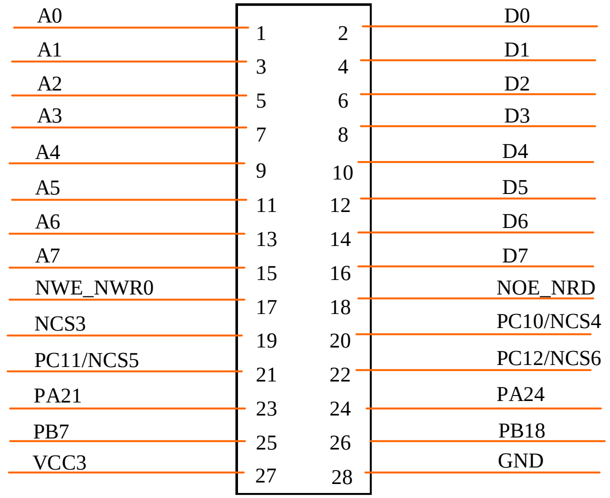
1-2: Internal ROM
2-3: External Flash (Default)

CN4 JTAG Connector



CN8 Local Bus Connector

1. 1x14 Pin Header Pitch 2.54mm
2. CN8 directly connect to CN1 of M501



CN7 (SPI) Pin Assignment

